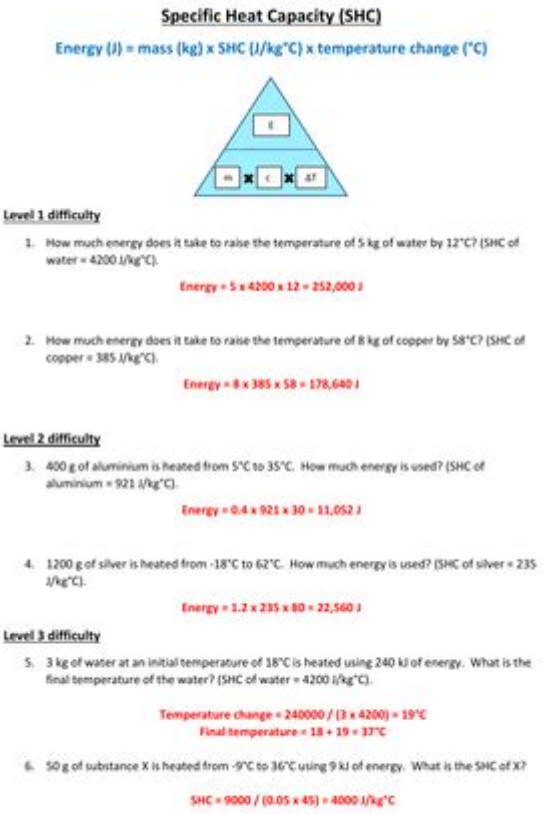
Specific Heat Capacity Questions And Answers



Specific Heat Capacity (SHC)

Energy (J) = mass (kg) x SHC (J/kg°C) x temperature change (°C)

Level 1 difficulty

1. How much energy does it take to raise the temperature of 5 kg of water by 12°C? (SHC of water = 4200 J/kg°C).

   Energy = 5 x 4200 x 12 = 252,000 J

2. How much energy does it take to raise the temperature of 8 kg of copper by 58°C? (SHC of copper = 385 J/kg°C).

   Energy = 8 x 385 x 58 = 178,640 J

Level 2 difficulty

3. 400 g of aluminium is heated from 5°C to 35°C. How much energy is used? (SHC of aluminium = 921 J/kg°C).

   Energy = 0.4 x 921 x 30 = 11,052 J

4. 1200 g of silver is heated from -18°C to 62°C. How much energy is used? (SHC of silver = 235 J/kg°C).

   Energy = 1.2 x 235 x 80 = 22,560 J

Level 3 difficulty

5. 3 kg of water at an initial temperature of 18°C is heated using 240 kJ of energy. What is the final temperature of the water? (SHC of water = 4200 J/kg°C).

   Temperature change = 240000 / (3 x 4200) = 19°C
   Final temperature = 18 + 19 = 37°C

6. 50 g of substance X is heated from -9°C to 36°C using 9 kJ of energy. What is the SHC of X?

   SHC = 9000 / (0.05 x 45) = 4000 J/kg°C

Specific heat capacity questions and answers are essential for understanding how different materials absorb and transfer heat. This fundamental concept in thermodynamics plays a crucial role in various scientific and engineering applications, from designing heating systems to understanding natural phenomena. In this article, we will explore specific heat capacity, answer common questions, and provide practical examples to enhance your understanding of this important topic.

Understanding Specific Heat Capacity

Specific heat capacity, often denoted as "c," is defined as the amount of heat required to change the temperature of a unit mass of a substance by one degree Celsius (or one Kelvin). It is an intrinsic property of materials, meaning it does not depend on the amount of substance present. The formula for calculating specific heat capacity is:

$$
c = \frac{Q}{m \Delta T}
$$

\]

Where:
- \(c\) = specific heat capacity (J/kg·°C)
- \(Q\) = heat added or removed (Joules)
- \(m\) = mass of the substance (kg)
- \(\Delta T\) = change in temperature (°C or K)

Units of Measurement

Specific heat capacity is typically measured in joules per kilogram per degree Celsius (J/kg·°C) or joules per kilogram per Kelvin (J/kg·K). Since the size of the degree Celsius and the Kelvin is the same, the two units can be used interchangeably in calculations involving temperature changes.

Common Questions About Specific Heat Capacity

Let’s delve into some frequently asked questions regarding specific heat capacity.

1. **What factors affect specific heat capacity?**

    - **Material Composition:** Different materials have different molecular structures, which influence their ability to store heat.
    - **Phase of the Material:** Solids, liquids, and gases have different specific heat capacities; for example, water has a high specific heat capacity compared to metals.
    - **Temperature and Pressure:** Specific heat can vary with temperature and pressure, particularly for gases.

2. **Why is water’s specific heat capacity so high?**

    - Water has a high specific heat capacity (approximately 4.18 J/g·°C) due to hydrogen bonding between water molecules, which requires a significant amount of energy to break.
    - This property makes water an excellent coolant and plays a crucial role in regulating climate and temperature in aquatic environments.

3. **How is specific heat capacity used in practical applications?**

    - **Climate Control:** Understanding specific heat capacity is vital for heating and cooling systems, ensuring efficient energy use.
    - **Cooking:** Different cooking materials require different heating times due to their specific heat capacities, affecting how food is prepared.
    - **Material Selection:** Engineers consider specific heat capacity when selecting materials for thermal management in various applications.

4. **Can specific heat capacity be negative?**

    - No, specific heat capacity cannot be negative. A negative value would imply that the material cools when heat is added, which contradicts the laws of thermodynamics.

5. **How does specific heat capacity relate to heat transfer?**

    - Specific heat capacity influences how quickly a material can absorb or release heat, affecting the rate of temperature change in a substance when energy is added or removed.
    - This relationship is essential in understanding phenomena such as thermal inertia and the behavior of materials in thermal processes.

Calculating Specific Heat Capacity: Examples

To better grasp specific heat capacity, let’s go through some calculation examples.

Example 1: Heating Water

Suppose you have 2 kg of water, and you want to raise its temperature from 20°C to 80°C. How much heat is required?

1. Identify the variables:
- Mass (\(m\)) = 2 kg

- Change in temperature (ΔT) = 80°C - 20°C = 60°C
- Specific heat capacity of water (c) = 4.18 J/g·°C = 4180 J/kg·°C

2. Apply the formula:
$$
Q = m \cdot c \cdot \Delta T
$$
$$
Q = 2 \, \text{kg} \cdot 4180 \, \text{J/kg°C} \cdot 60 \, \text{°C}
$$
$$
Q = 502800 \, \text{J}
$$

Therefore, the heat required to raise the temperature of the water is 502,800 Joules.

Example 2: Cooling Metal

Now, consider a 1 kg piece of aluminum with a specific heat capacity of 900 J/kg·°C. If the aluminum cools from 150°C to 50°C, how much heat is released?

1. Identify the variables:
- Mass (m) = 1 kg
- Change in temperature (ΔT) = 50°C - 150°C = -100°C (the negative sign indicates cooling)
- Specific heat capacity of aluminum (c) = 900 J/kg·°C

2. Apply the formula:
$$
Q = m \cdot c \cdot \Delta T
$$
$$
Q = 1 \, \text{kg} \cdot 900 \, \text{J/kg°C} \cdot (-100 \, \text{°C})
$$
$$
Q = -90000 \, \text{J}
$$

Thus, the heat released during the cooling process is 90,000 Joules.

Conclusion

Understanding specific heat capacity is crucial for various scientific and practical applications, from climate control to material science. By answering common questions and providing examples, we hope to clarify this essential concept. Whether you are a student, a professional, or simply curious, a solid grasp of specific heat capacity will enhance your comprehension of heat transfer phenomena in everyday life and complex

systems alike. Always remember that the ability of a material to absorb and release heat is not only a fascinating subject of study but also a key element in numerous technological and scientific advancements.

Frequently Asked Questions

What is specific heat capacity?

Specific heat capacity is the amount of heat energy required to raise the temperature of one kilogram of a substance by one degree Celsius.

How do you calculate specific heat capacity?

Specific heat capacity can be calculated using the formula: $c = Q / (m \Delta T)$, where c is specific heat capacity, Q is the heat added or removed, m is the mass of the substance, and ΔT is the change in temperature.

Why is specific heat capacity important in everyday life?

Specific heat capacity is important because it affects how quickly substances heat up or cool down, influencing cooking, climate, and even the design of thermal insulation materials.

What are the units of specific heat capacity?

The units of specific heat capacity are typically joules per kilogram per degree Celsius (J/kg°C) or calories per gram per degree Celsius (cal/g°C).

How does water's specific heat capacity compare to metals?

Water has a high specific heat capacity (approximately 4.18 J/g°C), which means it can absorb a lot of heat without a significant temperature change, whereas most metals have much lower specific heat capacities.

What is the specific heat capacity of air?

The specific heat capacity of air at constant pressure is approximately 1.005 J/g°C.

How does specific heat capacity relate to climate change?

Specific heat capacity affects how different materials absorb and release heat, influencing weather patterns, ocean currents, and climate systems, making it a key factor in understanding climate change.

Can specific heat capacity vary with temperature?

Yes, specific heat capacity can vary with temperature and pressure, especially for gases and some liquids, meaning the value is often given for a specific temperature range.

What role does specific heat capacity play in cooking?

In cooking, specific heat capacity determines how quickly a substance heats up or cools down, affecting cooking times and methods, such as boiling or frying.

What is the specific heat capacity of iron?

The specific heat capacity of iron is approximately 0.449 J/g°C, which is much lower than that of water, meaning it heats up and cools down more quickly.

Specific Heat Capacity Questions And Answers

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